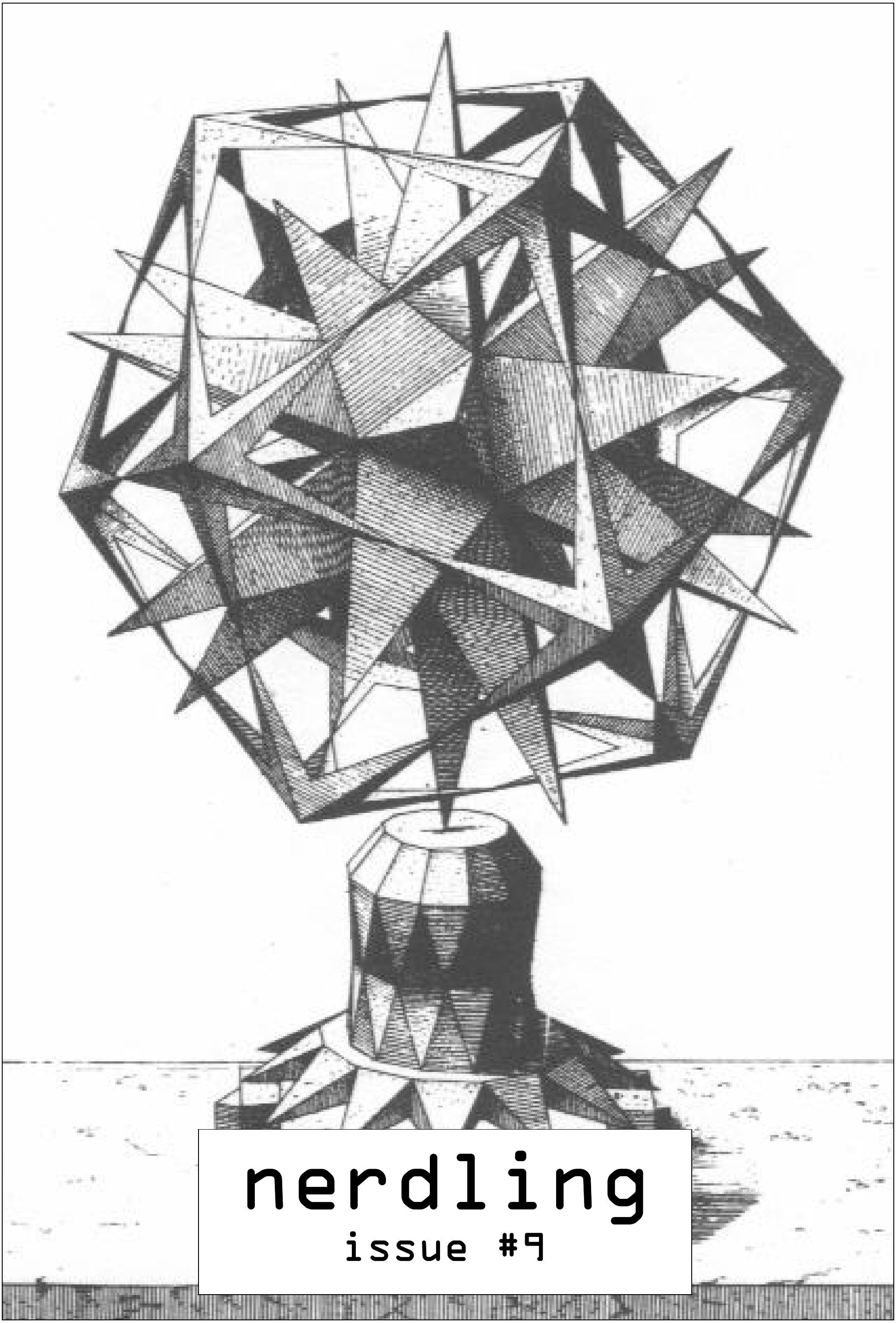


nerdling

issue #9

introduction

join our nerdist colony
and let your brain hang out
there's something here for those of you
who like to talk about

things like plasma physics
and star trek deep space nine
iastromathematics
or the hyperbolic sine

take rest o weary traveller
within these pages here
we've a sanctuary of nerddom
you may speak up without fear

on your thoughts about the daleks
or the greatest game of chess
nuclear waste issues
or which captain is the best

is it kirk, picard or archer
and is it really true
that the key to every problem
is the number forty two

talk nerdy to me baby
whisper fortran in my ear
i'll purr in bessel functions
as we chart the geek frontier

the übernerdling
editor, nerdling zine
September 2003

editor@nerdling.net

Front and back cover images from *Perspectiva Corporum Regularium* by Wentzel Jamnitzer, 1568.

contents

It's a favourite nerd pastime: picking sci-fi movies to pieces for their bad science. You know, stuff like, "Hey, Han and Leia so *should be wearing space suits. There's no* way *that asteroid is big enough to have an atmosphere," or the classic "*Like *you'd be able to* hear *that Klingon Bird-of-Prey exploding.* Everyone *knows sound can't propagate in a vacuum." Or, more basic but no less accurate, "Armageddon? The science in that movie is* crap*."*

Well, all of the above are pretty basic, right? Then here's one to challenge you, seeing how almost every science fiction movie and book gives a different answer:

What will happen if you get kicked out of an airlock without a spacesuit?

<u>Common scenarios, as portrayed in science fiction, include:</u>

- you will expand like a balloon and then explode, splattering blood everywhere [Dune]
- you will be fine, as long as you take a big breath first [Hitch Hiker's Guide]
- you'll start to bleed out of your eyes [Event Horizon]
- a lot of air will blow around, but nothing much else will happen [Star Trek: TNG, Stargate]
- you'll be fine as long as you're rescued within one or two minutes [2001: A Space Odyssey]
- your blood will boil; you don't have a chance [miscellaneous]

Most of the scenarios above get it almost, but not quite, totally wrong.

<u>This is, in short, what will actually happen:</u>

You will be conscious for about ten seconds, and rescuable *without permanent injury* within about two minutes—provided you do *not* hold your breath. You *will* expand like a balloon. You will *not* explode. Your blood will *not* boil. You will *not* become permanently blind. It *will* be painful.

<u>The actual scenario (the worst case likely to be survivable) in more detail:</u>

Initial signs of decompression:

- At the first moment of decompression (in the instance of a hull breach, for example) there will be an explosive noise.
- There will be a rapid rush of air out of the compartment. Paper and other items will be blown out. Dirt and dust will swirl and obscure vision for several seconds.
- Water vapour will condense out of the air, causing fogging. This will dissipate fairly quickly.
- The temperature will drop.

"The *Hitch-Hiker's Guide to the Galaxy* says that if you hold a lungful of air you can survive in the total vacuum of space for about thirty seconds."
—Douglas Adams,
The Hitch-Hiker's Guide to the Galaxy

Physical symptoms while in vacuum:

- There will be an initial rush of gas from the lungs. This is fine, as long as you're not holding your breath. If you try to hold your breath, your lungs will tear open, spilling air into your innards where big bubbles will course around and get lodged in your heart or brain. This would not be a good thing.
- After ten seconds you will lose consciousness. This is where you hope someone else will do the rescuing.
- Convulsions and then paralysis will follow.
- Water in the soft tissues and veins will vaporise. If you aren't wearing a pressure suit, you will swell to about twice your usual size. You have to hope your rescue party isn't so repulsed by your grotesque appearance that they won't grab you and drag you in the airlock.
- Water and gas will evaporate from your skin and airways, bringing your nose and mouth to near-freezing temperatures.

> "He could only count on the normal fifteen seconds of consciousness before his brain was starved and anoxia overcame him. Even then, he could still recover completely after one or two minutes in vacuum—if he was properly recompressed."
>
> —Arthur C. Clarke, *2001: A Space Odyssey*

If you aren't wearing a pressure suit, you will swell to about twice your usual size. You have to hope your rescue party isn't so repulsed by your grotesque appearance that they won't grab you and drag you in the airlock.

Upon recompression to at least one-quarter atmosphere within 90 sec. of decompression:

- Breathing usually begins spontaneously.
- Temporary blindness may result.
- Extreme pain may be felt.
- Usually a total recovery is made within three hours or so.

Other points:

Your blood won't boil. The elastic pressure of your blood vessels will keep the blood at a high enough pressure to prevent boiling at body temperature.

For example, if your blood pressure is 120/75, this means your vessels keep your blood at a minimum of 75 Torr (about 0.1 atmospheres) above external pressure. At 75 Torr, the boiling point of water is 46ºC—higher than body temperature.

(Other places in the body might have a lower pressure or temperature than this. In this case, a bit of water will start to vaporise, but these small pockets of localised vapour will act to increase the pressure and form an equilibrium. So you'll be OK.)

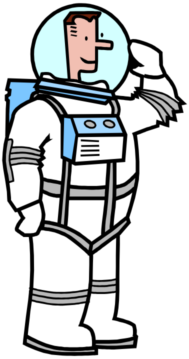
Has anyone ever experienced decompression in real life?

Yup. Some guys have survived. In 1966 a technician at NASA Houston was decompressed to vacuum in a space-suit test accident. He lost consciousness in 12-15 seconds, but after pressure was restored at 30 seconds he regained consciousness with no injury.

Some guys have died. In one incident, a guy could only be rescued after 2 to 3 minutes. He did not survive. The Soyuz-11 decompression accident in 1971 was also fatal.

“His right hand was twice the normal size… He tried to release some of his equipment prior to landing, but was not able to as his right hand was still in great pain. Three hours after landing his swollen hand and his circulation were back to normal.”

Some guys have experienced partial-body decompression. Balloonist Joe Kittinger lost pressurisation in his right glove during a high-altitude parachute jump in 1960. Shayler (see references below) wrote of the incident, “His right hand was twice the normal size… He tried to release some of his equipment prior to landing, but was not able to as his right hand was still in great pain. He hit the ground 13 min. 45 sec. after leaving Excelsior. Three hours after landing his swollen hand and his circulation were back to normal.”



There has even been an incident on the space shuttle. On shuttle flight STS-37, a part of an astronaut’s glove punched a hole in the pressure bladder between the thumb and forefinger. The astronaut didn’t even realise until afterwards; his skin and blood had sealed the opening, leaving him with only a painful red mark.

How long will it take for the air to get sucked out of a spacecraft?

Yeah, we’ve all seen this, too—a hole gets punched in the side of the *Enterprise* or whatever, and whup! all the air gets sucked out in a big maelstrom. Is it accurate?

If you try to hold your breath, your lungs will tear open, spilling air into your innards where big bubbles will course around and get lodged in your heart or brain. This would not be a good thing.

Well, the rule of thumb is this: if you put a one square centimetre hole in a one cubic meter volume, the pressure will drop by a factor or ten every hundred seconds, and this time scales up proportionally to the volume, and scales down proportionally to the size of the hole. So:

- a 1 cm^2 hole in a room-sized chamber (about 90 m^2) will give you about 2 hours before the air is at a critical pressure (i.e. at 15% of atmospheric pressure, at which you’re liable to lose consciousness).
- now say a wall gets knocked out or an airlock gets opened and the hole is 1 m^2. In this case you’ve got just a little over a minute before things are getting critical. In this situation, many science fiction movies are quite accurate.

So, in summary:

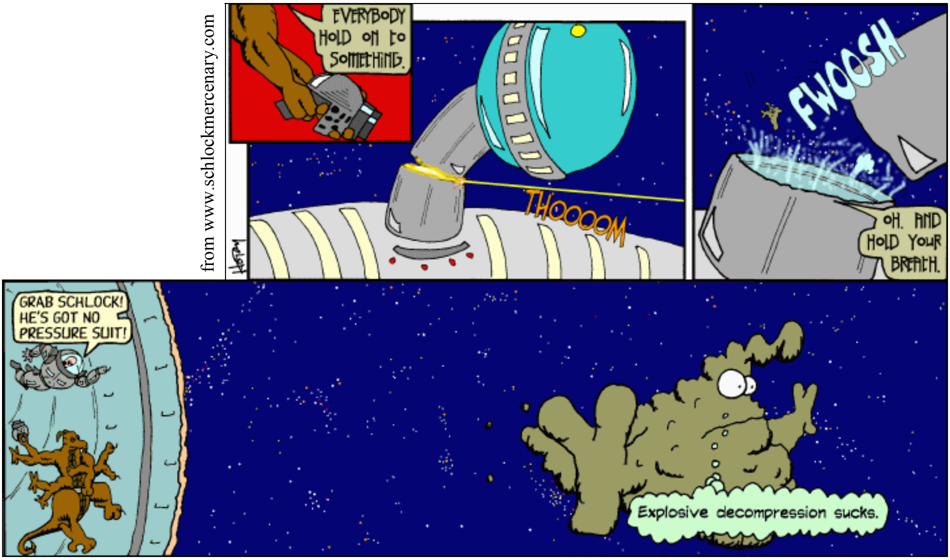
if you think you might find yourself floating around space without a suit in the near future, remember: you've only got ten seconds to help yourself, and above all, DON'T HOLD YOUR BREATH.

If you're reading this guide so you can get the decompression scene in your next sci-fi movie/TV episode/novel correct, you might even want to do a bit more technical research. In that case, check out some of the references below. Some of them are super-cool.

And if you're reading this so you can laugh condescendingly at the next movie you see that botches the whole decompression thing up, then I guarantee you'll be entertained long and often. Decompression scenes turn up in *everything* from Futurama cartoons to Kubrik movies—there was even one on the TV while I was typing this. Enjoy collecting technical mistakes!

For more detail see:

- *Human Exposure to Vacuum*, Geoffrey A. Landis: www.sff.net/people/Geoffrey.Landis/index.htp. This is probably the best summary you can get, with a reasonable technical depth.
- *National Geographic*, 1960. Here you'll find Kittinger's account of his ballooning incident.
- *Bioastronautics Data Book*, 2nd edition, NASA SP-3006. This has heaps of really great detail on physical effects, mainly from studies done on animals. Yes, I agree, it's pretty disgusting, but it's also a useful and interesting resource.
- *The USAF Flight Surgeon's Guide*, Paul W. Fischer. This is available at wwwsam.brooks.af.mil/af/files/fsguide/HTML/chapter_02.html and contains clearly-written technical information on what happens to the body, including the fascinating section on 'Gastrointestinal Tract During Rapid Decompression'.



from www.schlockmercenary.com

These Obscure Scientific Fields Actually Exist

Are you thinking about a career in science, but aren't exactly inspired by becoming a physicist, chemist, biologist or geologist? Are you after something a little unorthodox, obscure or left-of-centre? Or do you just want something cool to write in the 'occupation' space on your passport application form? Look no further than the list of scientific fields below.

algedonics	science of pleasure and pain
areology	study of Mars
auxology	study of growth
barology	the study of gravitation
brontology	the scientific study of thunder
ctetology	study of the inheritance of acquired characteristics
dactylography	the study of fingerprints
dysteleology	study of purposeless organs
edaphology	study of soils
exobiology	study of extraterrestrial life
gnosiology	study of knowledge
iatromathematics	archaic practice of medicine in conjunction with astrology
irenology	the study of peace
kalology	study of beauty
ktenology	the science of putting people to death
kymatology	the study of wave motion
loimology	study of plagues and epidemics
melittology	study of bees
myrmecology	study of ants
neurypnology	study of hypnotism
noology	science of the intellect
oneirology	study of dreams
onomasiology	study of nomenclature
ontology	science of pure being; the nature of things
oology	study of eggs
orthoepy	study of correct pronunciation
orthopterology	study of cockroaches
osmics	scientific study of smells
pataphysics	the science of imaginary solutions
pelology	study of mud
proxemics	study of man's need for personal space
psephology	study of election results and voting trends
thremmatology	science of breeding domestic animals and plants
threpsology	science of nutrition
ufology	study of alien spacecraft
vermeology	study of worms
xylology	study of wood
zenography	study of the planet Jupiter

How to make everyday stuff you do (or shouldn't do) sound really technical and clever

Don't feel intimidated if you're a non-scientist in an academic crowd—just tell them you're a halieutician or an oikologist and you'll impress the socks off them. Pharmacognosy, philematology, pseudology and scatology will allow you to justify all kinds of behaviour, and saying you're an oenologist or bromatologist sounds a lot better than a piss-pot or glutton. Use the words in the list below to your advantage.

autology	scientific study of oneself
balneology	the science of the theraputic use of baths
bromatology	the scientific study of food
halieutics	study of fishing
hamartiology	study of sin
oenology	study of wines
oikology	science of housekeeping
pharmacognosy	study of drugs of plant origin
philematology	the act or study of kissing
pseudology	art or science of lying
sarcology	study of fleshy parts of the body
scatology	study of obscene literature
zymology	science of fermentation

Sciences you should take care not to mix up

A slip of the tongue when introducing an eminent scientist at an important function can mean disaster—or else it can be very, very funny.

odology	science of the hypothetical mystical force of God
odontology	study of teeth
demology	study of human behaviour
demonology	study of demons
emetology	study of vomiting
emmenology	the study of menstruation
mycology	study of funguses
myology	study of muscles
parapsychology	study of unexplained mental phenomena
parasitology	study of parasites
phrenology	study of bumps on the head
phonology	study of speech sounds
tocology	obstetrics; midwifery
topology	study of places and their natural features
toxicology	study of poisons
toxophily	study of archery
urenology	study of rust moulds
urology	study of urine or the urinary tract

science fiction myths
debunked!

Myth: You can escape from a dalek just by climbing up stairs

This is an oldie but a goodie: if the *Dr Who* daleks are so fearsome an alien race, then why can you apparently get away just by climbing stairs?

The makers of the series realised this rumour was going around, and purposefully included a staircase-climbing scene in the final *Dr Who* story called “Remembrance of the Daleks”. In the episode we see that Daleks have a glowing hovering device which enables them to ‘float’ up stairs.

On the set, however, the Daleks were far less mobile than they appeared on screen. Actor John Scott Martin, who played Daleks in dozens of *Dr Who* episodes, recalls: “To make the Dalek live, I'd sit on a seat inside and tie myself in with a seatbelt. There was no floor so I'd propel myself after the Doctor with my feet. I certainly couldn't go up and down steps, and it wasn't feasible to work outside very much as even a stick could stop me in my tracks.”

FACTOIDS

courtesy of Harper's Indices, 2003

Number of new Indonesian islands discovered by satellite analysis in February : 1,000

Chance that a male human worldwide is a direct patrilineal descendant of Genghis Khan : 1 in 200

Average number of industrial compounds and pollutants that can be found in an American's blood and urine : 91

Minimum number of chronic medical disorders linked to exposure to industrial chemicals : 110

Number of the 158 used hard drives purchased for an MIT study this year that contained recoverable data : 129

Minimum number of credit-card numbers the hard drives contained : 6,650

Decibels of sound pressure employed by a new "thermoacoustic" refrigerator : 190

Decibels of sound pressure sufficient to ignite a person's hair : 165

Percentage points by which wearing a swimsuit increased the average math test score among men in a Michigan study: 4

Percentage points by which wearing a swimsuit decreased the average score among women : 6

Months after Ohio's Flesh Public Library installed Internet filters in 2000 that the filters blocked its own website : 12

Rank shared by Jesus Christ and Bill Clinton among "the greatest Americans of all time," according to Americans : 13

Sources for all statistics are provided in
Harper's Magazine, 2003 issues.

No One Ever Says Reykjavik in a Song

By chess correspondent Daniel Cotton

Bobby Fischer beat Spassky in Iceland '72.
I know a girl who's better looking but who thinks like Bobby Fischer too.
When Bobby Fischer was a kid they knew he was a prodigy.
I know a girl who's somewhat older but no less of an authority….
Reykjavik, no one ever says Reykjavik in a song.
Reykjavik, no one ever says Reykjavik in a song.
—The Lazy Susans

I don't think I'm going out on a limb by suggesting that the World Championship match between American Bobby Fischer and Russian Boris Spassky in Reykjavik in 1972 is the only chess match referred to in a song by an Australian rock act. Of course most avid listeners of JJJ will be familiar with the Lazy Susans' song 'Bobby Fischer' and the line 'Nobody ever says Reykjavik in a song' but fewer people know about the phenomenon of Bobby Fischer and what is arguably the greatest chess match of all time.

In many good stories the context is important, and that is certainly true in this case. The background is almost as interesting as the match itself. In the early 70s the cold war between the USA and the Soviet Union was in full swing. The Soviets at this time considered the chess board to be as important as the sporting field in asserting the superiority of communism as a political system and a way of life that produced extraordinary individuals. Consequently the Russian chess schools received the full financial backing of the regime. The Russian players were professionals who dominated world chess and in 1972 Boris Spassky was the best of them as FIDE World Champion.

"From the earliest days of Fischer's career to this very day, he has been labelled: brash, arrogant, selfish, self-centred, boorish, loutish, cruel, unreasonable, difficult, impossible, inconsiderate, ungrateful, petty, petulant, sulking, crass, insensitive, irrational, contentious, argumentative, aggravating, insulting, crazy, wicked, and mad. I would tend to agree."

—Paul Koller

By contrast, Bobby Fischer was one of two Americans who even attempted to make a living playing chess at the time while many of his contemporaries resorted to careers like driving Taxis (Rossolimo) to subsidise tournament winnings. It was fair to say that Fischer had an enormous talent for chess. In July 1956 he became, at age 13, the youngest winner of the US Junior Championship and in January 1958 he became the youngest winner of the US National Championship at only 14 years of age. In all he won the U.S. National Championship 8 times (in 8 attempts) and won more international tournaments than it would be worth mentioning here, some of which had only ever been won by Russian players before Fischer.

Many a fine player of chess has been quoted describing Fischer’s excellence. For example: Mikhail Tal (on playing against Fischer): “It is difficult to play against Einstein’s theory.” Isaac Kashdan: “In Fischer's hands, a slight theoretical advantage is as good a being a queen ahead.” Ken Smith: “Bobby Fischer is the greatest chess player who has ever lived.” Walter Shipman (on playing against Fischer): “It began to feel as though you were playing against chess itself.”

In addition to being a chess genius Bobby Fischer was also rather eccentric. A typical description of Bobby Fischer comes from Paul Kollar, a fine chess player in his own right: “It is, sadly, altogether too easy, in fact effortless, to find legions of people, not just chess players, who have every reason to say, and have (and please believe me that I do not do this out of spite or rancour) from the earliest days of Fischer's career to this very day, he has been labelled: brash, arrogant, selfish, self-centred, boorish, loutish, cruel, unreasonable, difficult, impossible, inconsiderate, ungrateful, petty, petulant, sulking, crass, insensitive, irrational, contentious, argumentative, aggravating, insulting, crazy, wicked, and mad. I would tend to agree.” Indeed the internet is as much littered with stories and quotes of Fischer’s arrogance and bigotry (towards primarily—but not exclusively—Russians, Jews and female chess players) as it is of tales of his invincibility on the chess board. This can easily be highlighted by quoting Fischer on the best known player in chess today: “I object to being called a chess genius, because I consider myself to be an all around genius, who just happens to play chess, which is rather different. A piece of garbage like Kasparov might be called a chess genius, but he is like an idiot savant, outside of chess he knows nothing.”

> “I consider myself to be an all around genius, who just happens to play chess […]. A piece of garbage like Kasparov might be called a chess genius, but he is like an idiot savant, outside of chess he knows nothing.” —*Bobby Fischer*

Fischer’s above quote seems even more absurd when you consider that he (at least in his public life) showed very little interest in anything apart from chess and fine suits; and didn’t do very well in school, reportedly because he was always daydreaming about chess.

> Walter Shipman (on playing against Fischer): “It began to feel as though you were playing against chess itself.”

All of these things—the Russians’ domination of chess, the Cold War and every aspect of Fischer’s personality—would make the 1972 World Championship Match one of the most intense, bizarre and exciting matches of all time.

See **nerdling** issue #10 for the second part of this article and the unbelievable story of the 1972 World Championship Match between Fischer and Spassky—including psychological war-games, hissy fits, accusations of spying, phone calls from the President and some very fine chess.

birthdays: september & october

Don't forget the exploding streamers and those crazy paper hats.

September 12: **Stanislaw Lem** (1921): Polish sci-fi author whose works include *Solaris, Cyberiad,* and *The Futurological Congress.*

September 13: **Roald Dahl** (1916): author of works including *Charlie and the Chocolate Factory*

September 19: **William Golding** (1911): author of *Lord of the Flies.*

September 21: **H.G. Wells** (1866): brilliant and influential sci-fi author of *The Invisible Man, The War of the Worlds* and *The Time Machine.*

October 5: **Robert Goddard** (1882): American physicist and inventor known as the 'father of modern rocketry'. In 1926 he was the first to construct and successfully test a rocket using liquid fuel. NASA's Goddard Space Flight Centre in Maryland is named in his honour.

October 8: **Frank Herbert** (1920): author best known for the *Dune* series.

October 10: **Ed Wood, Jr** (1024): The king of low-budget cult sci-fi film-making, responsible for movies such as *Plan 9 From Outer Space* ("Unspeakable horrors from outer space paralyse the living and resurrect the dead!"), *Night of the Ghouls* and *Orgy of the Dead.*

October 15: **Italo Calvino** (1923): member of 'experimental literature' group Oulipo, and author of works including *Cosmicomics* and *If On a Winter's Night a Traveler*.

October 21: **Ursula K. Le Guin** (1929): sci-fi writer of the *Earthsea* series, *The Left Hand of Darkness* and the *Hainish* series.

October 22: **Christopher Lloyd** (1938): actor who portrayed Doc Emmett L. Brown in the *Back to the Future* movie trilogy.

NERDLING FLIPBOOKS

Hi-tech goes old-school with the new *nerdling* flipbooks, which have photorealistic animations printed in paper 'flipbook' style. That's right, pretty pictures you don't have to plug into a power-point to watch.

Get them via the website at

>> www.nerdling.net <<

The Barometer Story

A tale of lateral thinking

Told by physics professor Dr Alexander Calandra of Washington University, St Louis, USA

Some time ago, I received a call from a colleague who asked if I would be the referee on the grading of an examination question. It seemed that he was about to give a student a zero for his answer to a physics question, while the student claimed he should receive a perfect score and would do so if the system were not set up against the student. The instructor and the student agreed to submit this to an impartial arbiter, and I was selected…

I went to my colleague's office and read the examination question, which was, "Show how it is possible to determine the height of a tall building with the aid of a barometer."

The student's answer was, "Take the barometer to the top of the building, attach a long rope to it, lower the barometer to the street, and then bring it up, measuring the length of the rope. The length of the rope is the height of the building."

Now this is a very interesting answer, but should the student get credit for it? I pointed out that the student really had a strong case for full credit, since he had answered the question completely and correctly. On the other hand, if full credit were given, it could well contribute to a high grade for the student in his physics course. A high grade is supposed to certify that the student knows some physics, but the answer to the question did not confirm this. With this in mind, I suggested that the student have another try at answering the question. I was not surprised that my colleague agreed to this, but I was surprised that the student did.

Acting in the terms of the agreement, I gave the student six minutes to answer the question, with the warning that the answer should show some knowledge of physics. At the end of five minutes, he had not written anything. I asked if he wished to give up, since I had another class to take care of, but he said no, he was not giving up, he had many answers to this problem, he was just thinking of the best one. I excused myself for interrupting him, and asked him to please go on. In the next minute, he dashed off his

answer, which was: "Take the barometer to the top of the building, and lean over the edge of the roof. Drop the barometer, timing its fall with a stopwatch. Then, using the formula $s=\frac{1}{2}at^2$ [distance fallen equals one-half the acceleration of gravity times the square of the time elapsed], calculate the height of the building."

At this point, I asked my colleague if he would give up. He conceded and I gave the student almost full credit. In leaving my colleague's office, I recalled that the student had said that he had other answers to the problem, so I asked him what they were. "Oh, yes," said the student. "There are many ways of getting the height of a tall building with the aid of a barometer. For example, you could take the barometer out on a sunny day and measure the height of the barometer, the length of its shadow, and the length of the shadow of the building, and by the use of simple proportion, determine the height of the building."

"Fine," I said. "And the others?"

"Yes," said the student. "There is a very basic measurement that you will like. In this method, you take the barometer and begin to walk up the stairs. As you climb the stairs, you mark off the length of the barometer and this will give you the height of the building in barometer units. A very direct method.

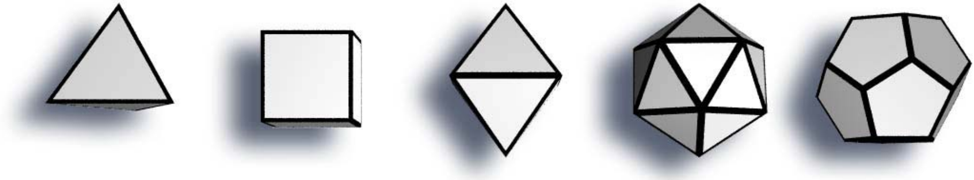
"Of course, if you want a more sophisticated method, you can tie the barometer to the end of a string, swing it as a pendulum, and determine the value of g [the acceleration of gravity] at the street level and at the top of the building. From the difference between the two values of g, the height of the building can, in principle, be calculated."

Finally, he concluded, "If you don't limit me to physics solutions to this problem, there are many other answers, such as taking the barometer to the basement and knocking on the superintendent's door. When the superintendent answers, you speak to him as follows:

"Dear Mr Superintendent, here I have a very fine barometer. If you will tell me the height of this building, I will give you this barometer…"

First published in Teacher's Edition of
Current Science, Vol 49, No. 14, January
6-10, 1964.

THE PLATONIC SOLIDS

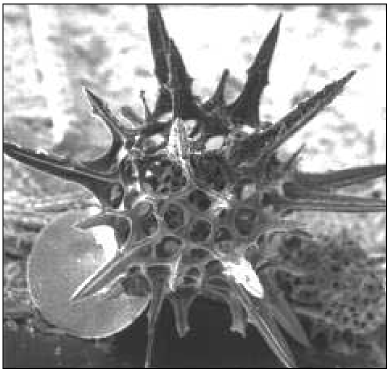


In issue 5 we started a section on the beautiful Platonic Solids, those five 'perfect' geometrical shapes that have entranced people from Pythagoras to Kepler to Da Vinci. This issue we continue with some examples of how the solids appear in nature. Don't forget that the best way to appreciate the solids is by making some of your own—you can use the instructions in issues 1 and 5 to make a set using nothing but A4 paper.

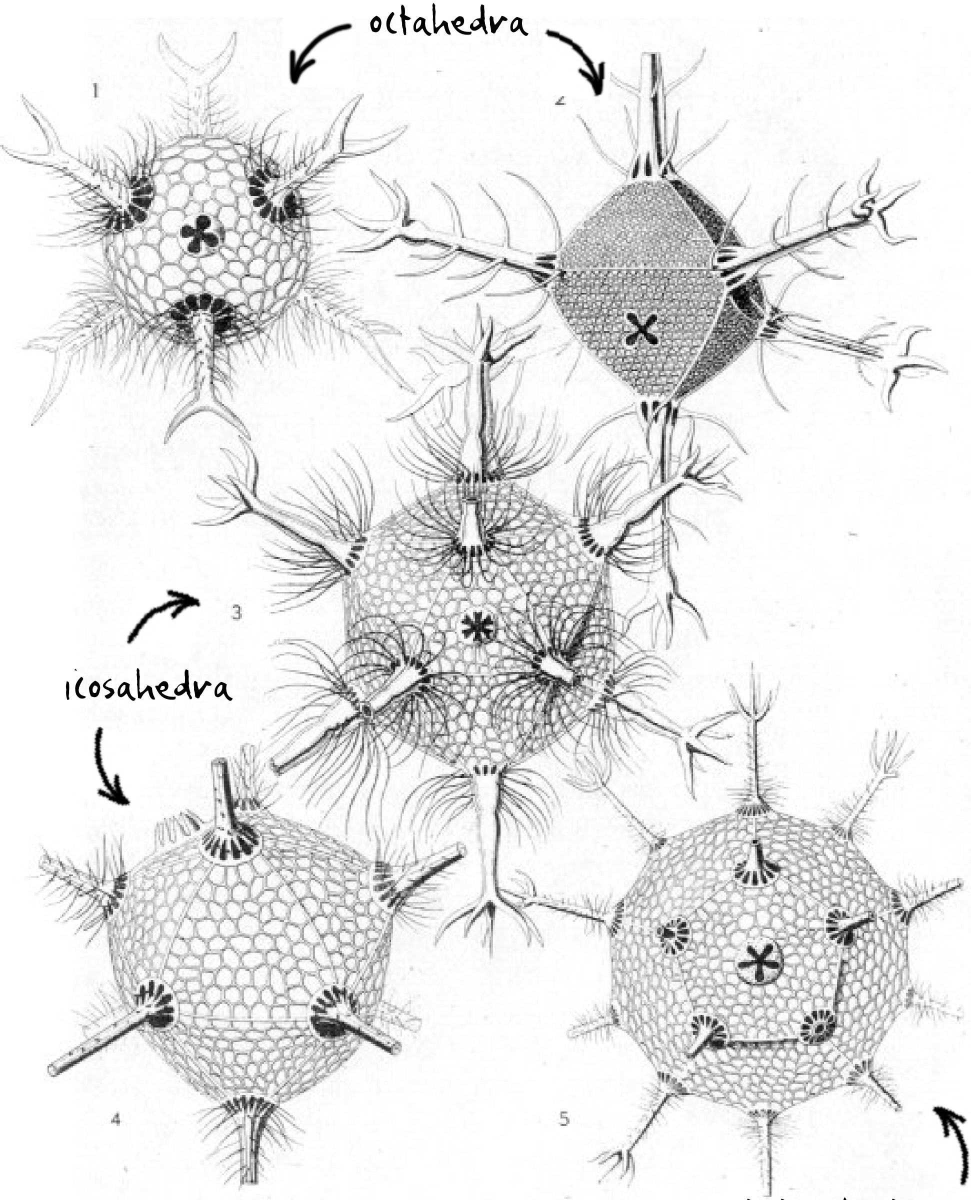
CHAPTER 3: THE PLATONIC SOLIDS IN NATURE

In many ways, the Platonic Solids represent the exact opposite of nature—they are idealised forms, impossible to represent perfectly from real materials. However, their basic forms do appear in many different aspects of the natural world, from crystals to plants and even to living creatures. Perhaps the most surprising shape to occur is the dodecahedron, made up of regular five-sided faces, yet it occurs naturally in pyrite crystals, pollens and the skeletons of tiny creatures.

Radiolaria are single-celled plankton which live in the ocean. They absorb silica from their surroundings and construct tiny skeletons of about one-tenth of a millimetre in diameter. These skeletons are often highly symmetric geometric forms. Some beautiful and detailed sketches of some of these forms were made by Ernst Haekel, the 19th century naturalist, and are shown on the facing page. He named them *circocorpus octahedrus*, *circorrhegma dodecahedra* and *circogonia icosahedra* for their resemblance to the Platonic solids.

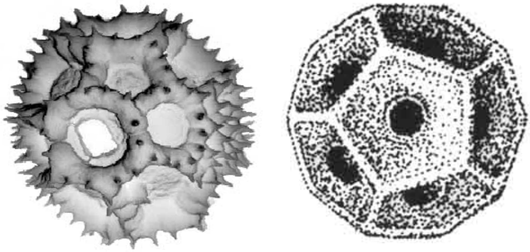


electron microscope mage of a radiolarian

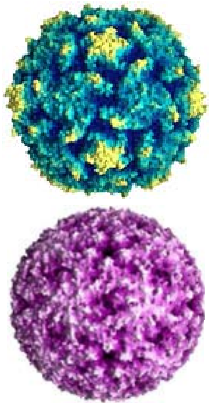


Radiolaria as sketched by Ernst Haeckel in "Kunstformen der Natur" (artforms of nature), 1904

Pollens can be in the shape of the Platonic solids. *Gypsophilia elegans* has the shape of a regular dodecahedron, *Oenothera odorata* is tetrahedral, and *dalia* is cubic.



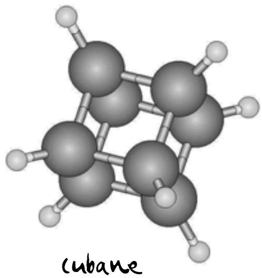
electron microscope image of dandelion pollen (truncated icosahedron), and sketch of pollen Gypsophilia elegans (dodecahedron)



Viruses can also be in these forms, including herpes, polio and Adenoviruses which are icosahedral, and Rice dwarf viruses which have dodecahedral symmetry.

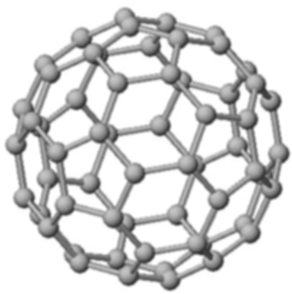
polio virus (top, icosahedral) and foot-and-mouth virus (bottom, dodecahedral)

Molecules sometimes appear in the shape of regular polyhedra due to atom bonding patterns. Methane (CH_4) is a tetrahedral molecule, and the appropriately named Cubane (C_8H_8) has carbon atoms which lie at the vertices of a cube. Many more examples occur in inorganic chemistry, especially with compounds involving the transition metals. in a molybdenum chloride ion ($Mo_6Cl_8^{4+}$) the chlorine atoms form a cubic cage around an octahedron made of metal atoms. Halides of platinum and zirconium are further examples of polyhedral molecules.



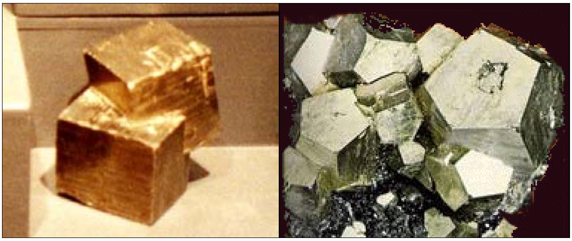
cubane

Carbon atoms can also arrange themselves into polyhedral forms. The buckminsterfullerene molecule, or ‘Buckyball’, is an allotrope (arrangement) of 60 carbon atoms in the form of a soccer ball pattern. This pattern is known as a truncated icosahedron—that is, an icosahedron with the points chopped off so that all the resulting faces are regular hexagons or pentagons.

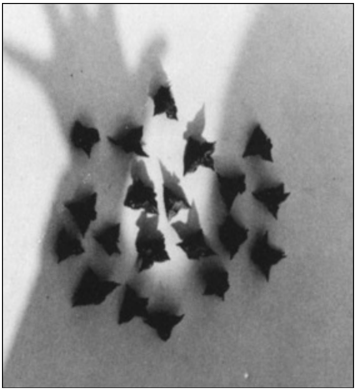


Bucky Ball

Crystals usually have highly ordered structures due to the bonding patterns of the constituent atoms. Pyrite is one of the most interesting minerals due to its ability to form crystals of several different shapes, including the cube and even the dodecahedron—a form which is known as a quasi-crystal due to its more complicated packing form.



pyrite crystals as interlocking cubes (left) and dodecahedra (right)

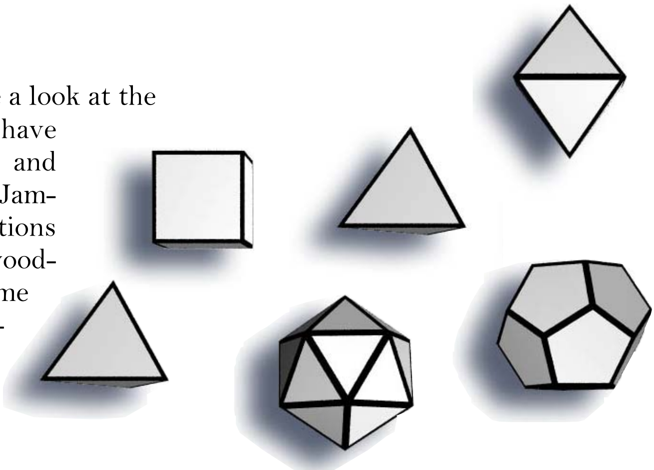


Tetrahedral water chestnuts, used as weapons by Ninja.

Seedpods also occur in Platonic geometries. One such example is the Japanese water chestnut which grows in the shape of a tetrahedron. These are said to have been a weapon of the Ninja, who would scatter them on the floor to slow down pursuers. No matter which way they land, a sharp point is left to point straight up into the enemy's feet.

Pomegranates give another example of geometric seedpods. As each seed grows it presses up against its neighbours, filling the available space and resulting in what is known as a rhombic dodecahedral distribution.

Next time: nerdling will take a look at the platonic solids in art. They have fascinated Dürer, Da Vinci and Dali alike. From Wentzel Jamnitzer's painstaking illustrations to Escher's fascinating woodcuts, stay tuned to see some beautiful geometric artworks.



Ancient Counting Systems

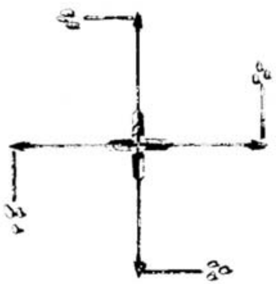
Mathematics began with the invention of numbers by which to count. This is not, however, as straightforward a concept as it may first appear.

Several tribes of Australian, New Guinean and Brazilian aborigines do not have names for numbers beyond 2 or 3—take for example the Australian aboriginal word “wagga” meaning ‘one crow’ and “wagga wagga” meaning ‘more than one crow’. Other tribes used a system based on the number 2, counting 1, 2, 2-1, 2-2, 2-2-1 and so on.

The aboriginal Anindilyakwan dialect spoken on Groote Eylandt, NT, Australia, shows a base-5 structure:

1: awilyaba	6: amangbala awilyaba
2: ambilyuma	7: amangbala ambilyuma
3: abiyakarbiya	8: amangbala abiyakarbiya
4: abiyarbuwa	9: amangbala abiyarbuwa
5: amangbala	10: ememberrkwa

Around the end of the ice age 10,000 years ago, hunters gradually gathered in the valleys of the Nile, Tigris and Euphrates rivers and took up farming. The associated need to track days and seasons, count grain and calculate land areas and taxes gave rise to more sophisticated counting systems. Higher-base systems were used, most often using base-5 (number of fingers on one hand), base-10 (fingers on both hands) or base-20 (total number of fingers and toes). Early 20-based systems are still remembered in the French words for 80 and 90, “quatre-vingt” and “quatre-vingt-dix” meaning “four-twenty” and “four-twenty-ten” respectively. There are approximately 1200 counting systems in Papua New Guinea and its vicinity alone, which use a wide variety of bases. The Sibiller tribesmen of New Guinea, for example, use a base-27 system, illustrated opposite, and the Kewa tribe count from 1 to 68 using different parts of the body.



This swastika shape, made of sticks and pebbles laid on the ground, is the number 21 as written by the Pueblo Indians of South-West America. Each of the four arrows, the four sticks and the 12 pebbles stands for 1. The ‘mystical middle’, where the arrows meet, is also worth 1.

For over half the course of civilization the Western world has written numbers in base-60, known as the ‘sexagesimal’ system, which was worked out by the ancient Mesopotamians before 1700 B.C. There are several advantages to this system. Because 60 has so many factors, it can be divided evenly into 2, 3, 4, 5, 6, 10, 12, 15, 20 and 30 parts without the need for fractions. It also fitted well with the Mesopotamian division of the year into 360 days. Originally a gap was used to represent zero; the first use of an explicit symbol to represent zero was found in Mesopotamian tablets dated 300 B.C.

At first sight the Mesopotamian number 7,9,3 might seem strange to us, and we would have to decode it as **7**,**9**,**3** = **7**×60×60 + **9**×60 + **3** = 25743. However, this is exactly what 7:09:03 means on a modern digital clock—25743 seconds past midnight.

Our base-60 time system was attempted to be reformed into a decimal (or base-10) system by the French in April 1795. This system comprised a 10 day week, a 10 hour day, a 100 minute hour and a 100 second minute. The system was repealed on 31 December 1805, partly due to pressure applied by Great Britain, and partly because the ten-days week was found difficult to cope with.

In an old Hawaiian dialect, the words used for numbers depended on what was being counted— 'forty canoes' used a different word to 'forty fish'. The same is true of the modern Japanese language: when counting long, skinny objects (such as bananas, pencils etc) the Japanese use different numbers than when counting round or spherical objects (such as apples or oranges).

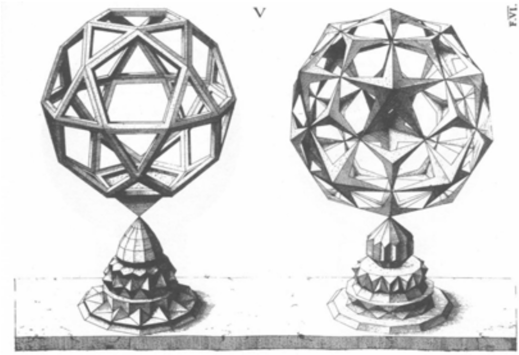
The base-10 system that we use for most things today is believed to have originated with the Hindus, however it wasn't well-known until 825 A.D., when it was popularised by an Arab mathematician named al-Khowarizmi of Baghdad. It took another two centuries for the number system to reach Spain, and reached England in the late 13th century in a book called *The Crafte of Nombrynge*. It ultimately superseded other systems because it was adopted by European merchants.

In the modern age, a new counting system has found wide usage—the binary, or base-2, system used by computers. In a way we've come full-circle, right back to the notation methods of primitive tribes.

A Sibiller tribesman of New Guinea can count to 27 by pointing to different parts of the body. He uses his right index finger to point to his left-hand fingers (1-5), then his left wrist, forearm, elbow, biceps, collar-bone, shoulder, ear and eye (6-13). The nose is 14. Pointing with his left index finger, he goes down his right side from eye to little finger for 15 to 27.

Illustrations and captions from *Life Science Library: Mathematics.*

How our numbers evolved: today's numerals derive from early Hindu script and Arabic numerals.



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